INFORMATION: Requirement for Fail-Safe Wing Flap Design; Ref. ANM-112 ltr dtd 12/8/81

Date: MAY 15 1984

Leroy A. Keith
Manager, Aircraft Certification Division, ANM-100

Connally
FTS: 446-2120

Managers, ASW-100 ACE-100, ANE-100, AWS-100

This letter is a reissuance of the December 8, 1981 letter, which provided guidance for fail-safe wing flap design. Additional guidance has been provided in this letter, relative to the application of damage tolerance criteria.

A review of service history indicates a high frequency of failures on the flap drive systems, some of which resulted in asymmetric flap extension. Several accidents have resulted from these unsymmetrical flap conditions. Inadvertent retraction of flaps at low speed can reduce wing lift to the point where continued flight is not possible. Also, the rolling movement associated with an asymmetric flap condition may exceed the capability of the flight controls to maintain level flight.

Several manufacturers of transport category airplanes recognize the unsafe condition associated with unsymmetrical flaps and have designed no-backs in the flap drive system. The no-backs act as brakes in the drive system preventing any movement of the flap surfaces in the absence of normal drive input. Service history indicates these devices are effective in preventing unsymmetrical flap conditions when failure in the drive system occurs.

Current fail-safe philosophy does not allow total loss of an airplane due to any single failure. Some airplane designs will allow retraction and/or separating of flaps with a single failure in the flap drive system, or in the flap support structure. In responding to our recommendation for issuance of a rule requiring no-backs in flap drive systems and fail-safe flap support structure, AVS-1 advised: "FAR 25.671 and 25.1309, which covers control systems and all systems respectively, require the airplane to be designed for external damage to these systems from any failure (including structural failures), which is not extremely improbable. This position is outlined in letters in the words of FAR 25.1309, 'The analysis must consider . . . possible modes of failure, including malfunctions and damage from external sources . . .', and in the preamble to Amendment No. 8A. Thus, the elements of your proposal are embodied in present interpretations of existing regulations." Accordingly, FAR 25.671 and 25.1309 should be interpreted to require application of fail-safe design to high lift devices; primarily the leading edge and trailing edge flaps.

Therefore, the wing leading edge and trailing edge flaps must:

1. Provide a positive means of holding flap segments in position with any single failure in the flap drive system or flap support linkages; unless,

2. it can be demonstrated by analysis and by flight tests that the airplane has adequate stall margins and maneuvering capability with any slat segment retracted or missing, and at normal takeoff and landing weights and airspeeds. If any single failure or any probable combination of failures will result in loss of more than one flap segment, then the most adverse configurations must be considered for flight test demonstration. Also, controllability and maneuverability must be

demonstrated in the asymmetric configuration without requiring exceptional piloting skill, alertness, or strength.

The flap support linkages referred to in this memo are hinges, tracks, and support linkages. They are considered part of the flight control system and therefore must meet the single failure condition of FAR 25.671. These support linkages are also considered primary f light structure and must comply with the damage tolerance requirements of FAR 25.571.

After failure of a single element in any flap support linkage, the remaining structure must be able to withstand the loading conditions in FAR 25.671(b). However, the single element failure required by 25.671 (c) is not a precondition for the damage tolerance assessment of 25.571(b), i.e., the damage tolerance assessment should start with an assumed initial crack in the first element.

Signed by
H.A. Parker
For
Leroy A Keith